E/CONF.39/E/73
20 Nov.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : B. 4

United Nations

# CHOICE OF CAPITAL INTENSITY IN OPERATION PLANNING FOR UNDERDEVELOPED ECONOMIES

By Department of Economic
and Social Affairs,
United Nations, New York

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# CHOICE OF CAPITAL INTENSITY IN OPERATION PLANNING FOR UNDER-DEVELOPED ECONOMIES

## I. Introduction

1. Industrialisation is a phase in a country's development in which its more or less stagnant economy is transformed into a self-generating developed economy capable of ensuring high and rising levels of living to the population. There is a general agreement among economists that the conditions for industrialisation are different and much less favourable in the under-developed countries of Asia, Africa and Latin America than they were in the corresponding phase in the now highly developed countries. High rates of population growth and lower average levels of income, combined with the "revolution of rising expectations", make the process of industrialisation more difficult, as well as urgent, emphasizing the importance of a greatly accelerated pace of development in the under-developed countries.

2. Industrialisation has three inter-related, but distinct aspects. First, it connotes conscious application of science and technology to the processes of production and distribution, making a radical break with centuries old productive processes based on ancient empirical techniques handed down from one generation to another. The adoption of new productive techniques derived from the conscious application of science and technology usually entails acquisition of new skills and work habits on the part of the labour force. Second, key sectors of the economy are inter-dependent and organically linked with one another in the integrated development of the whole economy. There is a notable increase in the relative weight of the industrial sector in the economy in the course of its development and the industrial sector becomes a dynamic force in modernising other sectors of the economy by providing them with more efficient capital goods. Finally, the rates of domestic savings and capital formation have to be stepped up to the levels where they can provide for the increase in population, ensure a rise in per capita consumption and reduce the reliance on foreign grants and other "non-commercial" foreign loans. This calls forth the acceleration of the present domestic rate of saving of four to eight per cent to the level of 15-20 per cent of the national income and diversification of the economy to permit an improvement in the balance of payments position by expanding the potential for exports and promoting import substitution.

3. Industrialisation in most under-developed countries has to take place in conditions of considerable initial under-employment, scarcity of capital and acute shortage of foreign exchange resources. The problem of widening employment opportunities leading to full employment in this phase of development is important not only in terms of relieving misery, but also in terms of most efficient utilisation of the abundant factor of production in the form of labour. It is in this conext that choice of capital intensity in operational planning needs to be examined.

## II. Theoretical Discussions

4. The theoretical discussion of the subject of capital intensity reveals two distinct trends; one favouring labour-intensive techniques and the other supporting capital-intensive techniques.1/ Those who prefer labour-intensive techniques focus the attention on the factor endowment of under-developed economies in the form of relative abundance of labour and scarcity of capital.

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1/ The trend favouring capital-intensive techniques emerged chronologically at a stage later than the trend favouring labour-intensive techniques.

This preference is expressed in two forms: the rate-of-turnover criterion[2] and the relative social marginal productivity criterion.[3] The rate-of-turnover criterion aims at maximising the ratio of output to capital. The social marginal productivity criterion aims at maximising the social marginal productivity, i.e. maximising the output for the economy as a whole. As there is virtually no loss of alternative outputs on account of the withdrawal of labour from agriculture or drawing upon from the pool of the unemployed, the social opportunity cost of labour is considered to be nil. This criterion, therefore, means the maximisation of the social marginal productivity of capital and coincides with the rate-of-turnover criterion. Both the criteria thus aim at the maximisation of immediate output and employment through the use of labour-intensive techniques.

5. Another group of economists suggests that the rate of investible surplus created in producing a unit of output should be made the basis of the selection of capital intensity. Since workers have a high marginal propensity to consume and owners of capital (governments, corporations, and private individuals) have high marginal propensity to save, the employment of capital-intensive techniques will result in greater savings and investment, and, consequently, a higher rate of growth in subsequent periods of time [4] than that obtained by employing labour-intensive techniques. The higher rates of investment will result in greater volumes of output and employment in the long run than those that would be obtained by employing labour-intensive techniques.

6. Employment of labour-intensive techniques and consequent maximisation of immediate output and employment would lead to the maximisation of consumption in the immediate future. The use of capital-intensive technique and consequent maximisation of growth rates and outputs in subsequent periods would lead to maximisation of consumption in the later periods possibly at the expense of consumption in the immediate period. There is, in essence, a conflict between present consumption and future product. However, it is admitted that the quantitative importance of this conflict varies in relation to the degree of effective control exercised on the real wage-rate through taxation, cost price and other direct and indirect controls. Attempts have been made to find a way out of this conflict by using time discount which inevitably involves political value judgments.[5]

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[2] See Professor J. J. Polak, Balance of Payments Problems of Countries Reconstructing with the help of Foreign Loans, Quarterly Journal of Economics, February 1943 and Norman S. Buchanan, International Investment and Domestic Welfare, New York, 1945.

[3] Professor A. E. Kahn, Investment Criteria in Development Programmes, Quarterly Journal of Economics, February, 1951.

[4] See Maurice Dobb, A Note on the So-called Degree of Capital Intensity in Underdeveloped Countries, Economic Appliquée, VII (1954), No.3 and Second Thoughts on Capital-Intensity, Review of Economic Studies, Vol. XXIV; Professors Galenson and Leibenstein, Investment Criteria, Productivity and Economic Development, Quarterly Journal of Economics, August, 1955, Professor K. N. Raj, Small-Scale Industries - Problems of Technological Change, Economic Weekly (Bombay) April 7 and 14, 1956; and A.K. Sen, Choice of Techniques - An Aspect of the Theory of planned Economic Development, Oxford, 1960. A detailed discussion of this type is to be found in the United Nations Bulletin on Industrialization and Productivity, No. 1, Sales No. 58.II.B.2.

[5] A. K. Sen, Choice of Techniques, op.cit., Chapters VII and VIII.

7. There are considerable difficulties in translating these theoretical conclusions into operational planning. Statistical information required for working out time preference for consumption at different points of time is not readily available. The assumption of invariant real wage-rate during the time horizon taken into account in working out time discounts is unrealistic; for, with the growth of capital accumulation, relative prices of labour and capital are likely to change in favour of the former factor. The conclusions are based on the assumption that there will be a continuing flow of labour from overcrowded agriculture into industry without affecting the real wage-rate or without incurring considerable costs in social overhead such as housing, schools, etc. This assumption is not borne out by experience. The implicit assumption of a high elasticity of substitution among factors of production and commodities is also not justified. Finally, only two factors of production are taken into account, viz., labour and capital. This ignores the existence of such scarce factors as skilled labour or managerial skills which have also to be taken into account.

## III. Estimation of Capital Intensity

8. It is necessary to distinguish two phases of an investment project, the construction phase and the operating phase (or manufacturing phase in industrial projects). A number of alternative techniques involving different combinations of labour and equipment may be available for each phase and should be taken into consideration in selecting capital intensity in each phase.6/ The collection and accessibility of these primary data are indispensable in making the choice of capital intensity in operational planning.

9. Two factors should be noted in estimating the capital intensity of projects, investment in social infra-structure and the level of utilisation of fixed capital, i.e., machinery and buildings. Efficient operation of enterprises requires, on the part of the labour force, a minimum of skills to operate machinery and equipment and habits of industrial work. This calls for a stable labour force conveniently housed near the location of enterprises. It, in turn, means investment in social infra-structure such as land reclamation, housing, schools, hospitals, etc. When calculating and comparing capital intensities involved in different techniques of production, it is necessary to take into account not only investment in machinery and installations, but also in social infra-structure. Expenditure on social infra-structure assumes considerable quantitative significance in the case of steel plants, fertiliser factories, and other projects which are built near the sources of raw materials and involve building new towns or settlements. Such expenditure may become an important item of total investment once the pool of the unemployed in the urban area is exhausted and additional labour has to be drawn from the surrounding rural areas; the larger the number of workers required in the operating phase, the greater will be the expenditure on social infra-structure. In technical language, the choice of capital intensity in the operating phase of a project has to be determined in conjunction with such factors as external economies and dis-economies.

10. As to utilization of equipment it is possible to combine different quantities of labour with a machine or a plant by means of multiple shifts, staffing in each shift, use of incentives, levels of repairs and maintenance, etc., yielding different levels of output.

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6/ On a macro-economic level, the construction phases of all projects taken together constitute the construction sector while other sectors of the economy comprise the operative phases of the projects.

11. The "conservative estimates" made by one United Nations expert in India disclose that from a given fixed investment, the output and employment in hand-fed operations can range from 1.00 to 6.42 and 1.00 to 5.35, respectively, depending on the pattern of management. In semi-automatic operations, the range for output can be from 1.00 to 5.56 and for employment from 1.00 to 4.45. The following table illustrates the range of variation in this area:

Estimated Range of Possible Output and Employment from a Given Quantity of Fixed Capital in India

| | Patterns of Management | Hand-Fed Operations | | Semi-Automatic Operations | |
|---|---|---|---|---|---|
| | | Index of Production | Index of Employment | Index of Production | Index of Employment |
| i) | Poorly managed one shift | 1.0 | 1.0 | 1.0 | 1.0 |
| ii) | Well managed with incentives, conventional staffing and one shift | 1.5 | 1.05 | 1.3 | 1.0 |
| iii) | Well managed with incentives, intensive staffing and one shift | 1.95 | 1.36 to 1.53 | 1.43 to 1.69 | 1.0 to 1.3 |
| iv) | Well managed with incentives, intensive staffing and three shifts | 5.50 | 4.08 to 4.59 | 4.03 to 4.77 | 3.0 to 3.9 |
| v) | Well managed with incentives, intensive staffing and three shifts and seven days | 6.42 | 4.76 to 5.35 | 4.70 to 5.56 | 3.5 to 4.55 |

12. These figures indicate that depending upon management there is a wide variation in the "effective" capital intensity for the same plant and equipment. The management element should be taken into account in estimating the capital intensity of a given technique. This in turn has implications in terms of training and improving managerial skills.1/

## IV. Guidelines for Choice of Capital Intensity

13. The policy making authorities have to take decisions regarding capital intensity for the individual sectors and the economy as a whole and they require some working rules or guidelines for this purpose; it is in the light of these guidelines that engineers and technologists can select techniques of production for various projects, redesign or modify plants and equipment and develop appropriate techniques of production. Some of the guidelines are briefly outlined in this section.

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1/ These figures also reveal the potential of expanding output in the operating phases of existing enterprises in under-developed countries by improved management. In connection with the management aspect see: United Nations Department of Economic and Social Affairs, Division of Industrial Development, Management of Industrial Enterprises in Under-developed Countries, Sales No. 58. II.B.5.

14. The rational use of limited resources available for the industrialisation of a country requires a long-term strategy of development. This strategy should be worked out on the basis of the initial stage of development with reference to such factors as the social, economic and administrative infra-structure; size and growth rates of the population, known physical resource endowment, and present and prospective importance and structure of foreign trade. For example, India's strategy of development with her vast population (large potential market), diverse natural resources and limited potential for exports will be different from that of a country with a small population, abundance in one key exportable natural resource (e.g., petroleum and natural gas), and consequent large potential export and favourable foreign exchange position.

15. A perspective plan with goals of given increases in per capita income and consumption in a specified time limit (e.g., 100 per cent increase in per capita income and 75 per cent increase in per capita consumption in 25 years) is elaborated on the basis of the long-term strategy of development. This plan will also govern the priorities and patterns of investment among individual sectors of the economy. It provides the basis for the medium-term plans in which the rates of growth and investment are scheduled so that the specified goals are obtained in the last year of the specified time-horizon. The perspective plan is continually revised in the light of experience, achievement and changing economic circumstances. At the same time, the time-horizon of the perspective plan is being extended by the length of the completed medium-term plan.

16. The long-term strategy of development, the ensuing priorities and patterns of investment in the perspective and medium-term plans and the relationships of interdependence among sectors of economy (e.g., relation between agriculture and the industrial sector, and dependence of manufacturing industries on supplies of raw materials and power, transport facilities, trained manpower, etc.) may have to be often worked out independently of immediate employment considerations.

17. The stage has been set for selecting capital intensities once the broad outlines of the medium-term plan, including approximate targets of annual growth rates of national income, consumption and investment are determined. The most important point at this stage of elaborating the medium-term plan is to focus attention on the number of additional workers (and total number of workers) that can be employed during the plan period, rather than on the total number of existing unemployed or under-employed workers. Even assuming the availability of complementary equipment even in the most rudimentary form (say, spades and baskets), the most important limiting factor on expansion of employment is the available supply of food and other wage-goods which determine the real wage rate. The volume of employment can be increased in direct proportion to the level of the minimum real wage-rate that is politically feasible in a given situation.

18. Various direct and indirect measures of control such as tax measures (especially commodity taxes, lowering the limit of exemption from income taxes, land revenue, etc.) and "safe" limits of deficit financing (i.e. permissible increase in the general price level) and price controls and compulsory procurement of food and cloth, etc., amount, in essence, to distributing the available supply of consumer goods among the largest possible number of employed persons. Theoretically speaking, the ceiling on employment might be full employment of the entire labour force, if it is possible to achieve a sufficiently drastic cut in the real wage rate.

19. The creation of employment to the level of a "ceiling" arrived at by various considerations of economic and political nature represents the maximum utilization of labour (the abundant factor of production) which is feasible under the given circumstances, and represents the key factor in determining the capital intensity. It should be noted that such a "ceiling" embraces the labour force to be employed in all projects and sectors of the economy.

20. The feasible maximum number of additional jobs that can be created in the plan period is arrived at by substracting the existing level of employment from the "ceiling" thus obtained. The Planning Authorities may find two possible situations. The new employment that would be created by the use of the most labour-intensive techniques in every project in the plan may be less than or roughly equal to the maximum feasible number of additional jobs, or may exceed it. In the first case the decision on the choice of capital intensity is relatively easy, namely to use the most labour-intensive techniques in every project.

21. However, in most under-developed countries it is possible to undertake simple projects such as irrigation, housing, road building, etc. with the help of simple tools (say, spades and baskets). These simple tools are either already available or can be easily manufactured locally. Alternatively, they can be imported by spending a small amount of foreign exchange. Consequently, it should be possible to create new employment of this type in almost all countries unless inadequate organizing or managerial ability operates as a bottleneck in the execution of projects. Even if such a bottleneck does exist, it is possible to overcome it by training suitable personnel within a short period. Inability to create new employment in the plan period equalling the feasible maximum number of additional jobs implies a failure to fully utilize the potential resources for realizing the maximum pace of development. The first situation, therefore, is likely to be, at best, a temporary one and most under-developed countries are already likely to be found, or will be soon, in the second situation.

22. The choice of capital intensity in the second situation is a complex task requiring the selection of differing capital intensities for different projects in such a way that a new employment created by them is roughly equal to the feasible maximum number of additional jobs in the plan period. The use of the maximum capital-intensive techniques is almost certain not to fulfill this condition. It is, therefore, necessary to discover how best this possibility of differential capital-intensities can be utilized in the interests of the economy.

23. Historical evidence indicates that the cost of labour relative to capital will increase over time once accumulation of capital outruns growth in the labour force, that is, the value of equipment per worker begins to increase. This trend in most countries is reinforced by enacting of minimum wage legislation (reflecting social conscience and rising expectations), unionization of labour and a steady increase in the opportunity cost of the transfer price of labour from agriculture to other sectors of the economy 8/

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8/ As workers begin to move from overcrowded agriculture to other sectors of the economy, average employment and income of the labour force retained in agriculture will increase. This, in turn, will lead to the increase in the wage-rate that will have to be offered to workers in agriculture to induce them to take up employment in other sectors of the economy.

24. This means that the labour costs, i.e. operational costs, will rise over time. This trend element should be taken into account in working out differential capital intensities for individual projects. A distinction was made earlier between two phases of an investment project, the construction phase and the operating phase (or manufacturing phase in industrial projects). The increase in the cost of labour relative to capital over time will affect only the operating phase. It is therefore preferable to use more capital-intensive or less labour-intensive techniques in the operating phase of projects than in the construction phase. In other words, the construction activities throughout the economy should receive top priority in the use of labour-intensive techniques.

25. The techniquesdesigned for the operating phase are embodied in machinery and equipment. The impact of the rise in future operating costs is in proportion to the length of time over which the machinery and equipment will continue to be in service. The relevant time-horizon comprises (i) a gestation period or the time taken up in the installation of machinery and equipment and (ii) the lifetime of machinery and equipment. The longer the relevant time-horizon (gestation period plus the life of the plant), the higher should be the capital-intensity of the techniques chosen. For example, some of the major transport installations such as railways and ports provide services for a very long period (50 years or more) and should consequently embody relatively higher capital intensity than others with a shorter time-horizon.

26. A distinction should be made between the productive operations which can be mechanized without undue additional costs at a later stage and processes whose subsequent mechanization would involve heavy additional costs. The latter should embody relatively more capital-intensive techniques than the former. This proposition is merely a corollary of the preceding proposition about a relative time-horizon.

27. Immediate cost effects of the choice of capital intensity cannot be altogether neglected. It has special relevance in mixed economies. Its maximum impact is on the enterprises manufacturing important intermediate projects and where the time-horizon of the project is long.

28. To sum up, the following guidelines should be followed in the choice of differential guidelines. First, labour-intensive techniques to the extent that it is technically and organizationally feasible should be employed in the construction phase of all projects. Second, a system of descending order of capital-intensive techniques (progressively less capital-intensive or more labour-intensive techniques) in the operative phase should be selected in (a) machine-manufacturing projects and transport installations with a long time-horizon (as defined earlier); (b) other basic industries projects producing important intermediary products and services also with a long time-horizon, and (c) all other projects. Special consideration should be given to export industries projects facing competition in the world market from developed countries. Within this system of preference in capital-intensities, productive operations in the operating phase of a project which cannot be subsequently mechanized without additional heavy costs should embody relatively higher capital-intensive techniques. The aggregate new employment generated in all projects using the above scale of capital intensities should be approximately equal to the maximum feasible number of additional jobs in the plan period.

29. Application of these guidelines will enable planning authorities, to the extent that it is possible, to select factor proportions consistent with the maximum use of labour within the given institutional and social limitations; to prevent an uneconomic structure of costs of production and losses arising from technological obsolescence; and to safeguard the position of export industries facing foreign competition.

## IV. Technological Possibilities for Labour-Intensive Techniques

30. There is a general tendency in under-developed countries to employ the most up-to-date techniques in all sectors of the economy and for all types of operations. The up-to-date techniques are mostly capital-intensive because they are developed in advanced countries and are generally aimed at substituting capital for labour because of rising wage costs and increasing abundance of capital. In the first place, capital-intensive processes are often identified with "industrialization" and have a prestige appeal. Engineers often have a psychological bias in favour of such techniques because of their educational background and conscious or unconscious identification of "progress" with the latest available techniques. Business managers often prefer them in order to avoid irksome labour problems. This constellation of forces operates against the use of the economically correct factor proportions. It is, therefore, useful to draw attention to areas of industrial activities which might be usefully considered for deploying or developing capital-saving and more labour-intensive techniques.

31. There is great scope for employing labour-intensive techniques in the construction phase of all projects. At one extreme will be found almost completely manual methods of high labour intensity, including human carriers (or animal power); at the other extreme, completely mechanized operations of excavation, levelling and hauling. A number of alternative techniques which involve a wide range of different combinations of labour and equipment are thus available for construction activity.[9] Earth-moving operations, including excavation, hauling, filling and compacting are particularly adaptable to the use of highly labour-intensive techniques. The use of such techniques has, by and large, no adverse effect on the quality of the end product (houses, factory buildings, dams, canals, roads, etc.).[10]

32. Employment of labour-intensive techniques in the construction phase of all projects is also important because the unemployed and under-employed workers in under-developed countries largely form a group of unskilled workers. The study prepared by the Division of Industrial Development in the Department of Economic and Social Affairs of the United Nations [11] revealed that the share of total construction activity in incremental gross fixed capital formation in the economy is, on an average, higher in under-developed countries and varies from 46 per cent to 69 per cent in under-developed countries.[12] "Even in modern industrial countries constructional

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9/ "Capital Intensity in Heavy Engineering Construction", published in Bulletin on Industrialization and Productivity, No. 1, United Nations publication, April 1958 (Sales No. 58.II.B.2).

10/ Pyramids in Egypt and the Taj Mahal in India conclusively demonstrate this fact.

11/ "Capital Intensity in Heavy Engineering Construction", op. cit.

12/ Ibid., p. 36, see Table I in the Statistical Annex.

activity which lends itself to hand labour is as much as 50 or 60 per cent of gross fixed investment, so it is not difficult to think of labour creating capital without using any but the simplest tools."[13] The data on cost elements of earth-moving operations by different techniques are given in Table II in the Statistical Annex. It should be noted that the earth-moving operations are quite important, even in the construction of the industrial enterprises. For example, the construction of the Rourkela Steel Plant (excluding township, etc.) in India involved 6.1 million cubic metre of earthwork.[14]

33. There are a number of "technologically flexible" industries which allow for considerable substitution between labour and capital and which are therefore amenable to the use of labour-intensive techniques in the manufacturing phase. In weaving cloth, for example, there is a spectrum of techniques involving different combinations of labour and capital ranging from primitive throw-shuttle hand looms, fly-shuttle hand looms, semi-automatic hand looms, cottage power looms, factory non-automatic power looms to automatic power looms. The case of wood-working technology also falls in the same category.[15] Cotton spinning, garments, foodstuff, leather, rubber products, bricks, roofing tiles, certain chemicals, brass utensils, steel furniture, etc. are other examples of "technologically flexible" industries.

34. Manufacture of a number of goods such as radios, television sets, bicycles, agricultural equipment, etc. involve production and assembly of components. These also represent examples of "technologically flexible" industries because it is possible to organize production of components by means of labour-intensive techniques under sub-contracting arrangements and in accordance with specifications of the assembly plants. This mode of the use of labour-intensive techniques has been extensively employed in Japan. Again, labour-intensive techniques can be efficiently employed in the manufacture of accessories for the automobile industries, railways, shipping, etc.

35. The existence of the market for the second-hand machines which have become obsolescent in advanced countries on account of rising costs of labour is, in a way, an index of the scope of the "technologically flexible" industries. It may be advantageous to employ the second-hand machines in several cases first because in many cases they represent equipment of lower capital intensity and more labour-intensive techniques, and second because they permit an account of their shorter life, a more flexible equipment policy by making it possible to shift to new or different equipment at an earlier date in the future than would have been the case with new equipment.[16] Alternatively, they provide the prototype design of equipment embodying relatively more labour-intensive techniques for manufacture in under-developed countries.

36. There is a clear distinction between ancillary or auxiliary processes and "core" operations in industrial enterprises. The former consists of

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13/ Lewis, A.W., Economic Development with Unlimited Supply of Labour - The Manchester School of Economic and Social Studies, May 1954, op.cit. pp.160-161.

14/ Report of the Ministry of Steel and Fuel (Department of Iron and Steel), 1960-61, Government of India, New Delhi, 1961, p. 14.

15/ Boon, G.K., "Choice of Industrial Technology: The Case of Wood-working", March, 1960, Industrialization and Productivity Bulletin No.3, United Nations, N.Y.

16/ "Second-Hand Machines and Economic Development", Netherlands Economic Institute, Rotterdam, May 1958. Publication No. 15/58.

material handling, ware-housing, packaging, flying squads and maintenance shops for "core" operations, tool maintenance and making room, utilities, etc. It is possible to use labour-intensive techniques in some of these ancillary processes even in "technologically inflexible" industries where it is difficult to replace capital by labour in the "core" operations.

37. The attention of engineers, scientists and technicians should be drawn to the possibilities of selecting capital saving techniques in the "core" operations of the "technologically inflexible" industries. Research and development of such techniques should be undertaken where they do not exist. This can sometimes be done by designing the equipment on the basis of the process layout instead of the product or line layout especially in engineering industries. There exists a great scope of research in designing equipment and developing processes to reduce the size of operations costs with minimum increases in such costs. (In technical terms, this would amount to reducing the slope of the curve of economies of scale). This type of research has considerable importance because of the fact that in many underdeveloped countries not only the size of the present market, but also that of the potential market in the foreseeable future is likely to be relatively small.

38. Recent developments in the technology for cement production illustrate the point in case. In the beginning of the nineteenth century, cement was manufactured in vertical kilns, which presented a number of disadvantages, in particular, that of uneven burning of the clinker. Later in that century, these were replaced by rotary kilns, which improved the quality of cement and permitted large-scale production, and are still the standard equipment in the industry. In recent years, improved small-scale vertical kilns have been designed and built in Switzerland and Australia, and are being introduced in the United States. These kilns present several advantages, in particular, the fact that they can be constructed mobile. They may be especially suitable for some countries in the developing areas since they require substantially less investment per unit of output than the conventional equipment, and may thus permit the manufacturing of cement in small scale.

39. It is probable that the use of multi-purpose machinery would permit more economic operations than that of single-purpose equipment.17/ With multi-purpose equipment, the size of plant can be reduced and production of small quantities may become economic. Many plants in the less-developed countries are characterized by the use of labour-intensive processes involving short production runs of a variety of items. Market demand is not sufficient in many cases to warrant installation of specialized machinery whose capacity in any single part or product would be excessive. A development which may be of interest for plants of this type is the designing of modular units or "building block" equipment made up of standard component units which can be replaced so as to permit the use of the machinery for a variety of purposes. Modular-constructed machine-tools are particularly versatile.

40. The advantage of large-scale production over small-scale production in unit costs is derived partly from purely technological economies of scale and partly from the facilities of economic "overheads" such as research, bulk buying and selling, cheaper and easier credit facilities, advertising,

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17/ It should be noted that the use of multi-purpose machinery is technologically impractical in the chemical industry and certain other industries.

standardization of products, specialized facilities for tooling and repairs, organization of specialized maintenance staff, facilities for specialist advice, etc. The latter- facilities of "economic" overheads - can be provided to small production units by surrounding them with appropriate agencies - private, co-operative, or statutory - which can take over the functions of economic "overheads" and perform them as common services to small units. The important among these agencies are the state-sponsored industrial finance corporations, industrial extension service, sale and purchase co-operatives, industrial research institutions, corporations supplying machines on hire-purchase basis, firms specializing in tooling, repairs, etc., credit co-operatives, and so on. The chief advantage of industrial estates consists in the incorporated common services performing many of these functions of economic "overheads". Failure to distinguish between unit cost advantages arising from purely technical economies and those from other economies by engineers and technicians not infrequently results in adoption of more capital-intensive techniques than could be justified under the circumstances.

41. It should be recalled that the research in and application of the labour-intensive techniques should be organized in accordance with the guidelines on differential capital intensities in individual sectors within the framework of the average capital intensity for the economy arrived at by the planned volume of investment and the ceiling on employment.

TABLE I

Importance of Construction Expenditure in National Expenditure: Selected Countries - 1953

| Country | Share of gross fixed capital formation in gross national product | Share of Construction in gross fixed capital formation | Non-Residential Construction: As percentage of total construction | Non-Residential Construction: As percentage of gross fixed capital formation | Share of Construction industry in total factor payments[a] |
|---|---|---|---|---|---|
| **Industrial Countries:** | | | | | |
| Federal Republic of Germany | 20.6 | 47.4 | - | - | 6.6[b] |
| Netherlands | 20.7 | 46.5 | 62.4 | 29.0 | 5.4 |
| Norway[c] | 29.2 | 50.0 | 54.8 | 27.4 | 8.5 |
| United Kingdom | 13.4 | 51.7 | 48.2 | 24.9 | 5.8 |
| United States[c] | 16.1 | 58.6 | 61.4 | 36.0 | 4.6 |
| **Other Countries:** | | | | | |
| Argentina[c] | 15.5 | 68.8 | - | - | 5.0 |
| Brazil | 14.2 | 57.5 | - | - | - |
| Burma | 14.1 | 76.5 | - | - | 2.8 |
| Chile | 9.3 | 60.4 | 46.4 | 28.0 | 3.2 |
| Ecuador | 11.1 | 46.3 | 74.6 | 34.5 | 2.9 |
| Ghana | 13.3 | 54.2 | 80.8 | 43.8 | - |
| Israel | 23.7 | 70.8 | 53.7 | 38.0 | 5.8 |
| Philippines | 6.8 | 62.1 | 63.2 | 39.2 | 3.3 |
| Union of South Africa | 26.5 | 56.1 | - | - | - |
| Yugoslavia[d] | 32.0 | 48.5 | - | - | 7.2 |

Source: Statistical Office of the United Nations, Statistics of National Income and Expenditure, Statistical Papers, Series H, No. 10 (January 1957). For definition of each item and national differences in coverages and definition, see source.

(a) Payments to factors of production in the construction industry as a per cent of gross domestic product at factor cost (total factor payments); for Chile, Israel and the Philippines, of net domestic product at factor cost.

(b) 1950.

(c) Government fixed capital formation excluded in part from capital formation.

(d) Gross material product; capital formation includes changes in inventories. For definition of concept of gross material product, see source.

Reproduced from Industrialization and Productivity, Bulletin 1, "Capital Intensity in Heavy Engineering Construction", p. 36.

TABLE II

Capital Intensity and Unit Costs for a Combined Operation of Excavation, Transport and Compaction

| Country | Capital Input (US$ per thousand cub.metre-kilometres) (1) | Labour Input (man/hrs.per cub.metre-kilometres) (2) | Capital Labour Input Ratio (1):(2) (3) | Cost per Cub.Metre-Kilometre (US$) (4) | Wages (US$ per hr.) (5) | Year (6) |
|---|---|---|---|---|---|---|
| France | 167 | 148 | 1.1 | 0.67 | 0.71 | 1958 |
| India | 190 | 600 | 0.3 | 0.60 | 0.13 | 1953 |
| Poland(a)(b) | 48 | 957 | 0.05 | 0.62 | 0.21 | 1952-1954 |
| Union of Soviet Soc. Republics | 180 | 158 | 1.2 | 0.67 | 1.04 | 1956 |

Source: Industrialization and Productivity, Bulletin No. 3, "Capital Intensity and Costs in Earth-moving Operations", p. 13.

(a) For details on exchange rate used in calculation, see Appendix II.

(b) Capital and labour inputs based on distribution of costs for entire project.

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